Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Wireless E911 Location Accuracy Requirements	)	PS Docket No. 07-114
	)	

COMMENTS OF NEXTNAV, LLC

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SUMMARY

The Commission is correct in concluding that a 3 meter vertical location metric is technically achievable and can be implemented successfully by wireless carriers prior to the April 2021 and 2023 deadlines. A 3 meter metric will provide a substantial benefit to public safety because it will identify the correct floor of a wireless callers to E911 in most instances.

The public safety community has uniformly rejected the proposal for a 5 meter metric as insufficient to support emergency response. The Commission should also conclude that a 2 meter metric is not yet feasible, although it could well become achievable in the foreseeable future.

While no option is perfect, the Commission should recognize that a 3 meter metric will provide an enormous improvement to emergency response times. In contrast, if the Commission refrains from adopting a z-axis metric, the wireless carriers may be forced to rely upon an address-based dispatchable location approach even though recent tests revealed that the National Emergency Address Database ("NEAD") remains highly inaccurate and may never be sufficiently accurate to provide a reliable tool for public safety, particularly with reference point density requirements of only 25 percent.

In adopting a 3 meter metric, the Commission should give significant consideration regarding whether to require its compliance for 80 percent of wireless calls, for only those devices equipped with barometric pressure sensors, or for only devices manufactured after a certain date. To enable wireless carriers to report compliance with the first deadline in less than two years, the Commission likely should adopt certain safe harbors, such as requiring initial compliance only with newer handsets equipped with pressure sensors and possibly by requiring that older handsets that are equipped with pressure sensors be made compliant using over-the-air software updates.

To ensure technical neutrality, the Commission should refrain from adopting a specific measurement standard that must be used to report vertical location information. If a standard is adopted, however, it should be height above ellipsoid ("HAE"), which is the most accurate and reliable means available and is also the standard used for the global positioning system ("GPS"). Other options, such as height above mean sea level ("MSL"), height above ground level ("AGL") or the floor number assigned by the building owner, would introduce additional variables in the calculation process, some of which would be impossible to achieve using existing technology and would inevitably reduce reliability and cause confusion for public safety.

The Commission also does not need to adopt any special data protection or security requirements for z-axis data. The data protection and security requirements that were adopted for the NEAD were necessitated because it contains highly personal information regarding individuals that may never call E911, including their address and billing information. In contrast, z-axis data (just like the location data that is already generated by smartphones using GPS), can be fully controlled by consumers using the settings on their personal devices.

The lengthy record in PS Docket 07-114 already demonstrates that the adoption of a vertical location metric of 3 meters will provide substantial public interest benefits in terms of financial savings and lives saved. The Commission's previous analysis of a study on ambulance response times in Salt Lake City demonstrated that a reduction in response time of one minute will greatly increase the likelihood of recovery for individuals in distress. Coupled with this, field tests performed in 2014 by the San Francisco Fire Department demonstrated that giving first responders access to vertical location information that is accurate within 3 meters can greatly reduce the time it takes to find a wireless caller inside a large building.

Further, the cost of compliance with a 3 meter vertical metric is minimal. As the Commission has acknowledged, most wireless devices are already equipped with barometric pressure sensors and the software to calibrate these sensors can often be added to smartphones through over-the-air updates. The external infrastructure needed to monitor local atmospheric conditions and report this information to smartphones can also be deployed in a relatively inexpensive manner, ensuring that highly accurate z-axis information can be provided to public safety for an aggregate cost of less than a penny per month per handset. Given these compelling factors, the Commission should further its public interest obligation by promptly adopting a z-axis metric of 3 meters and requiring the major wireless carriers to comply with this requirement by April 2021 in the most populous 25 cellular market areas ("CMAs") and by April 2023 in the most populous 50 CMAs.

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COMMENTS OF
NEXTNAV, LLC

NextNav, LLC ("NextNav"), by its attorneys, hereby responds to the Commission's Fourth Further Notice of Proposed Rulemaking ("*Fourth FNPRM*") seeking comment on the adoption of a vertical accuracy metric of +/-3 meters to support emergency first responders.

For more than a decade, NextNav has been working with the wireless industry and the Commission to develop location technology that can precisely identify the indoor location of wireless callers to E911 emergency services in a highly accurate and reliable manner. NextNav's metropolitan beacon service ("MBS") is a terrestrial technology that replicates the global positioning system ("GPS"), but with far greater penetration into indoor locations where GPS is largely unavailable.

Independent tests conducted more than six years ago by the Commission's Communications Safety Reliability and Interoperability Council ("CSRIC") confirmed that NextNav's MBS technology achieves vertical location accuracy of within 3 meters in tall urban structures,[1] a conclusion that the Commission's *Fourth FNPRM* acknowledges.[2]

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[1] *See Report – "Leveraging LBS and Emerging Location Technologies for Indoor Wireless E9-1-1*," CSRIC III, Working Group 3 (March 14, 2013).

[2] *See* Wireless E911 Location Accuracy Requirements, PS Docket No. 07-114, *Fourth Further Notice of Proposed Rulemaking*, FCC 19-20, ¶ 24 (March 18, 2019) ("*Fourth FNPRM*").

That same CSRIC report identified the ultimate objective for the Commission in this proceeding, explaining that the public safety community requires the identification of a "specific dispatch-able building (and floor in multi-story environments)."[3] As the *Fourth FNPRM* correctly concludes, achieving this "floor level" requirement necessitates the adoption of a vertical location metric of no more than 3 meters because "3 meters will provide sufficient accuracy to identify the caller's floor level in most cases."[4] The Commission should therefore promptly adopt a +/-3 meter z-axis accuracy metric and concurrently require that the major wireless carriers certify implementation of technologies proven through independent testing to meet this accuracy metric for 80 percent of indoor wireless calls in the most populous 25 cellular market areas ("CMAs") by April 2021 and in the most populous 50 CMAs by April 2023.

I. A VERTICAL LOCATION METRIC OF 3 METERS IS TECHNICALLY FEASIBLE AND REQUIRED BY PUBLIC SAFETY

Since first demonstrating the highly accurate capabilities of its indoor location technology in 2012, NextNav has repeatedly shown that its MBS technology achieves accuracy of within 3 meter (and more recently within 2 meter) in multiple independently-conducted tests. Most recently, NextNav participated in the Stage Z test bed conducted by the major wireless carriers in February 2018. The independent test bed administrator concluded that NextNav's MBS technology was accurate within 1.8 meters or better for 80 percent of indoor fixes and 3 meters or better for 94 percent of indoor fixes,[5] ensuring its consistent performance within an accuracy

[3] *See "Indoor Location Test Bed Report*," CSRIC III, Working Group 3, *Public Safety Forward* at 9 (March 14, 2013).

[4] *Fourth FNPRM*, ¶ 12.

[5] *See Report on Stage Z*, 911 Location Test Bed, LLC PS Docket 07-114, at 126 (Aug. 3, 2018) ("*Stage Z Report*").

metric of 3 meters or less. The details of the test results are extensively discussed in NextNav's comments in this docket, dated October 1, 2018 and NextNav incorporates those comments herein by reference.[6]

The Stage Z Report also documented vertical location test results for a technology developed by Polaris Wireless that also uses barometric pressure sensors, but did not employ active calibration of the barometric sensors during the test process.[7] The Stage Z Report acknowledges that the test results for Polaris "may underestimate the performance results that might be achieved" if a calibration approach had been employed.[8] Given the fact that Polaris separately indicated that it will use active sensor bias compensation in real world conditions,[9] it is reasonable and appropriate to conclude that the Stage Z test process confirmed, once again, that existing location technologies available from multiple vendors can reliably achieve floor level vertical accuracy within +/-3 meters for at least 80 percent of indoor wireless calls to E911 emergency services.

As acknowledged in the *Fourth FNPRM*, the public safety community has confirmed that a vertical metric of +/-3 meters is sufficient to achieve their objective of floor level accuracy.[10] As NENA explained, "[i]t should be clear from these comments that public safety cannot accept anything less precise than ±3 meters accuracy in the z-axis."[11] The International Association of

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[6] *See* Comments of NextNav, LLC, PS Docket No. 07-114 (Oct. 1, 2018).

[7] *See Stage Z Report* at 51.

[8] *Id.* at 51.

[9] *See id.* at 133-134 (separate statement of Polaris Wireless).

[10] *See Fourth FNPRM*, ¶ 12.

[11] Reply Comments of NENA: The 9-1-1 Association, PS Docket No. 07-114 at 2 (Oct. 11, 2018).

Fire Fighters further explained that the public safety community requires "the provision of vertical location information that provides true floor level accuracy (*i.e.*, no more than 3 meters)."[12]

Although a 3 meter requirement may not always identify the exact floor of a wireless caller to E911, it marks a vast improvement over the current situation in which first responders often have no idea where in a large building a wireless caller may be located. Emergency personnel inside the building can also use vertical location technology in their own equipment (possibly supplied through FirstNet or even an application on their own consumer device) to match the altitude of the wireless caller, greatly accelerating the search process.

In stark contrast, the public safety community has made it abundantly clear that a vertical metric of +/-5 meters is insufficient. As NENA explained, a 5 meter metric equates to three adjacent floors and "[f]orcing responders to search three separate floors for a 9-1-1 caller — two of them with similar chances of containing the caller — during a violent crime or a fire rescue should not be a reality in 2018, let alone in 2021." [13] The National Association of State 911 Administrators also concluded that "a metric of +/- 5 meters is not accurate enough for 911 and first responders"[14] and the National Public Safety Telecommunications Council explained that a "+/-5 meter vertical accuracy metric fails to offer the level needed to protect the public in emergency situations."[15] APCO International summed up the views of public safety, explaining

[12] Comments of The International Association of Fire Fighters, PS Docket No. 07-114 at 1 (Oct. 11, 2018) ("*IAFF Comments*").

[13] Comments of NENA: The 9-1-1 Association, PS Docket No. 07-114, at 3 (Oct. 1, 2018).

[14] Comments of the National Association of State 911 Administrators, PS Docket No. 07-114, at 1 (Oct. 11, 2018) ("*NASNA Comments*").

[15] Comments of the National Public Safety Telecommunications Council, PS Docket No. 07-114, at 1 (Oct. 1, 2018).

that the 5 meter metric proposed by the major wireless carriers "fails the American public and the dedicated public safety professionals who need actionable, accurate location information to find 9-1-1 callers during emergencies."[16]

In expressing support for the adoption of a 3 meter metric, NextNav acknowledges the views of some within public safety that the vertical location metric should be set aggressively at 2 meters.[17] NextNav, however, agrees with the Commission that a 2 meter metric is not yet technically achievable on a consistent basis.[18] Although NextNav has demonstrated sub-2 meter accuracy in test beds, additional developments remain necessary in barometric sensor technology, manufacturing processes and system development to meet such a metric at scale. Thus, the Commission is correct in concluding that a 2 meter metric "may become achievable in the long term as technology continues to evolve."[19]

Finally, NextNav is concerned about the apparent strategy of those parties that may not want the Commission to adopt any z-axis metric at all, presumably in the hope that the wireless carriers and the Commission will feel additional pressure to dramatically improve the National Emergency Address Database ("NEAD") to reliably provide the appropriate "door to kick down."[20] The Commission's rules appear to require wireless carriers to implement a dispatchable

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[16] Comments of APCO International, PS Docket No. 07-114, at 1-2 (Oct. 1, 2018).

[17] *See NASNA Comments* at 1; Comments of The Boulder Regional Emergency Telephone Service Authority ("BRETSA"), PS Docket No. 07-114, at 4-5 (Oct. 1, 2019).

[18] *Fourth FNPRM*, ¶ 19.

[19] *Id.*

[20] *See, e.g.,* Letter from Jeffrey S. Cohen, Chief Counsel, APCO International, to Marlene Dortch, Secretary, Federal Communications Commission, PS Docket No. 07-114, at 1 (Apr. 22, 2019) (expressing support for requiring dispatchable location information for all 9-1-1 calls and concern over the proposed z-axis (vertical) location accuracy metric).

location solution by the 2021 and 2023 deadlines if the Commission refrains from adopting a z-axis metric.[21]

Unfortunately, the Commission's rules do not impose *any* accuracy or percentage of calls requirements for the dispatchable location option, particularly with respect to vertical accuracy, instead relying on a threshold density of NEAD reference points as a compliance metric.[22] Coupled with this, recent tests on the NEAD show the resulting location data may be far too unreliable to be used by public safety,[23] an outcome that NextNav repeatedly warned about after the Roadmap was proposed.[24] Given these factors, the public safety community and the Commission should be legitimately concerned that the wireless carriers may report compliance with an address-based dispatchable location approach in April 2021 and 2023 using the relatively

[21] *See* 47 C.F.R. § 20.18(i)(2)(ii)(C) (providing the options of a dispatchable location or "z-axis technology in compliance with any z-axis accuracy metric *that has been approved by the Commission*") (*emphasis added*).

[22] *See* 47 C.F.R. § 20.18(i)(2)(ii)(C)(1) (requiring only that "[i]n each CMA where dispatchable location is used: nationwide CMRS providers must ensure that the NEAD is populated with a sufficient number of total dispatchable location reference points to equal 25 percent of the CMA population").

[23] *See E911 Location Test Bed Dispatchable Location Summary Report*, ATIS Test Bed Program Management (April 2019).

[24] *See* Comments of NextNav, LLC, PS Docket No. 07-114, at 16 (Dec. 15, 2014) (explaining in detail that, rather than provide a dispatchable location, the NEAD may, at best, provide an associated address for wireless callers that are in the vicinity of a particular registered access point, and, in most locations, "(particularly where E911 emergencies most frequently occur), the LBS transmitter registrations in the database will be non-existent or grossly insufficient to provide location information of significant value to public safety"); Letter from Bruce A. Olcott, Counsel to NextNav, LLC, to Marlene H. Dortch, Secretary, Federal Communications Commission, PS Docket No. 07-114, at 3 (Nov. 19, 2014) (noting that "even if all of the multi-year aspects of the voluntary roadmap were in place today, the percentage of E911 delivered with 'dispatchable address' would be *de minimis*").

low threshold that they populated the NEAD with the required number of reference points,[25] even though the location data provided by those reference points will not produce an actionable dispatchable location.

To help prevent this unfavorable outcome, the Commission and the public safety community should recognize that a 3 meter vertical location accuracy rule can be implemented successfully by wireless carriers and will provide an enormous improvement over the status quo. Further, the enforcement of a 3 meter metric should provide a sufficient regulatory impetus to prompt market forces to ensure that an even more accurate vertical threshold is achieved in practice. The Commission's focus on wireless location accuracy has already generated substantial competition among providers of wireless location services. These companies are competing for contracts with the major carriers not just based on price, but also on the quality of their services. Consistent with this, NextNav has made no secret of its objective to provide wireless carriers and the public safety community the highest degree of accuracy possible regardless of whether the FCC metric is established at 3 meters.

Therefore, the Commission should conclude that, as a regulatory measure, the adoption of a 3 meter metric is adequate to serve the needs of public safety and should be adopted. The Commission should also conclude that compliance with a 3 meter metric is clearly feasible from a technical standpoint and therefore must be implemented by the major wireless carriers no later than April 2021 in the top 25 CMAs and by April 2023 in the top 50 CMAs.

[25] *See* 47 C.F.R. § 20.18(i)(2)(ii)(C)(1).

II. NUMEROUS FACTORS ARE RELEVANT IN DECIDING HOW TO APPLY THE PROPOSED 3 METER METRIC TO ACTUAL WIRELESS CALLS TO E911

The *Fourth FNPRM* raises important questions regarding the manner in which carriers will be required to comply with the Commission's vertical location metric. Specifically, the notice asks whether the z-axis metric should apply to 80 percent of all wireless calls, only to mobile devices equipped with barometric pressure sensors, or only to devices manufactured after a certain date?[26]

Given that the first z-axis implementation milestone is now less than 24 months away, the Commission must recognize that undeniable limitations exist in how rapidly calibrated altitude calculation capability can be perpetuated throughout the universe of existing handsets. Although providing 3 meter altitude accuracy for 80 percent of wireless calls in the top 50 CMAs might constitute the ideal eventual outcome, or could potentially constitute a 'safe harbor' for proof of compliance, it may be appropriate to consider establishing a required percentage of new handsets with this capability coincident with the current 2021 and 2023 milestones. Additionally, since only software modifications are required for existing handsets that are equipped with barometric sensors, the Commission might consider requiring a percentage of software or operating system updates to include this capability effective with the current 2021 and 2023 milestones. NextNav has been exploring these options with handset manufacturers and the carrier community and intends to comment further on these issues as the most reasonable approaches become apparent.

[26] *Fourth FNPRM*, ¶ 14.

III. IF THE COMMISSION DOES SPECIFY THE MANNER IN WHICH VERTICAL LOCATION INFORMATION IS REPORTED, IT SHOULD REQUIRE HEIGHT ABOVE ELLIPSOID, WHICH IS THE MOST ACCURATE AND RELIABLE REPORTING METHOD AVAILABLE

The *Fourth FNPRM* seeks comment on whether to require wireless carriers to report vertical location information using a specific measurement standard or whether the Commission should decline to mandate a single standard.[27] In order to ensure technical neutrality in the Commission's rules, the Commission should avoid adopting a required reporting standard at this time. If the Commission does adopt a uniform standard, however, it should be height above ellipsoid ("HAE"), which is the standard employed by GPS.

HAE is a coordinate-based system that was derived using a mathematical model of the Earth's gravitational (magnetic) field, known as the World Geodetic System ("WGS") 84, to approximate the shape of the Earth.[28] WGS 84 uses the Earth's calculated center of mass as a coordinate and therefore provides a reference system that is highly accurate on a global basis.[29]

HAE is intended to coincide with mean sea level ("MSL"),[30] but it is far more accurate because the mean ocean surface is not perfectly level.[31] Therefore, HAE is more appropriate for

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[27] *See id.*, ¶ 14.

[28] *See World Geodetic System 1984 (WGS 84),* Office of Geomatics, National Geospatial-Intelligence Agency, *available at* http://earth-info.nga.mil/GandG/update/index.php?dir=wgs84&action=wgs84#tab_egm84 (*last visited* May 20, 2019) ("*Office of Geomatics Website*").

[29] *The EGM96 Geoid Undulation with Respect to the WGS-84 Ellipsoid*, NASA's Archive of Space Geodesy Data, *available at* https://cddis.nasa.gov/926/egm96/doc/S11.HTML (last visited May 20, 2019).

[30] *See Office of Geomatics Website.*

[31] *See Model Software for World Magnetic Model*, NOAA National Centers for Environmental Information, *available at* https://www.ngdc.noaa.gov/geomag/WMM/newsoft.shtml (*last visited* May 20, 2019); *see also Height Reference System Modernization*, Natural Resources Canada,

use than MSL for highly accurate positioning. In addition, the use of HAE for GPS means that new indoor location technologies that report data in HAE can be integrated more easily with existing location technologies, such as A-GPS.

The option to employ height above ground level ("AGL"), although appealing in concept, would introduce unhelpful variables and reduce reliability. This is because AGL begins with HAE or MSL as a data input and then requires additional calculations using additional data inputs, including the precise horizontal location of the device. Thus, even if the vertical location of a caller is known with precision using HAE, the conversion of that information to AGL requires an assumption of the caller's horizontal location at a degree of accuracy not currently supported by the Commission's wireless location rules.

Specifically, AGL is determined using digital elevation models ("DEMs") that digitize terrain height resolutions using horizontal grids that are as small as 1 meter squared.[32] Thus, in order for a wireless device to report its correct AGL, it must first know its correct DEMs location, possibly within a single meter. Of course, this would not be possible if the wireless device can determine its horizontal location only within 50 meters. The current 50 meter horizontal accuracy objective for E911 calls will contain a multitude of different DEM altitudes and thus a multitude of different AGL elevations. Unless or until a much more precise horizontal caller location can be assured, it is folly to pick only one of many possible AGL translations and report that as accurate within 3 meters.

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available at https://www.nrcan.gc.ca/earth-sciences/geomatics/geodetic-reference-systems/9054#_Toc372901506 (*last visited* May 20, 2019).

[32] *See Fourth FNPRM*, ¶ 14, n.38.

A requirement that z-axis data be reported as actual floor level would add even more variables and inconsistency to the indoor location reporting process. As noted above, an initial problem with translating altitude to floor level information is that this cannot be reliably calculated absent precise x/y information regarding the horizontal location of a device. Although the Commission's rules require the provision of x/y information within 50 meters, a 50 meter radius can encompass multiple buildings and adjacent buildings (particularly old and new buildings) which often do not have matching floor levels. Thus, any computation of floor level based on a x/y location within 50 meters will likely be inaccurate if the incorrect building is assumed.

Even if the correct building is identified, actual "floor level" is often based on conditions that are very specific to the building in question and would require detailed mapping and information collection regarding every building. No better example exists than the Commission's headquarters, where the Eighth Floor is not on the eighth story of the building. Such variations in floor numbers (such as skipping the thirteenth floor) are very common, but not applied in a sufficiently consistent manner to be computed by location service providers without local inspection of each building.

Given the numerous important factors that are relevant in identifying an appropriate standard for reporting vertical location data, the Commission should refrain at this time from mandating the use of any single standard by location service providers. If a specific standard is adopted, however, it should be HAE since it is the most accurate and reliable standard that is available and also because it is already employed for GPS.

IV. ALTHOUGH ADDITIONAL PRIVACY AND SECURITY MEASURES WERE REQUIRED FOR THE NEAD, NO SUCH MEASURES ARE NEEDED FOR THE 3 METER VERTICAL METRIC

When the Commission approved the creation of the NEAD in 2015, it adopted specific data protection and security requirements for the NEAD and its users.[33] These protections were needed not because the NEAD would be used by carriers to help identify the locations of wireless callers to E911, but because the NEAD would contain very personal information about individuals, including individuals who may never place a call to E911 emergency services.

As the Commission acknowledged in its *Fourth Report and Order*, numerous public interest organizations expressed concern about the aggregation within the NEAD of consumer address or billing information juxtaposed with ISP and Wi-Fi MAC addresses, presenting new and challenging risks that required extraordinary measures of protection. As the public interest organizations explained "users of networked devices likely do not expect that information about their device and physical address will be stored in a national database that is accessible to multiple parties," that "as the database is updated over time, it could reveal the exact address of individuals who have moved from one location to another and brought their networked devices with them," and that "software vulnerabilities make it possible for malicious third parties to obtain their victims' MAC addresses remotely, which … could then be used to derive physical address as well."[34]

[33] *See* Wireless E911 Location Accuracy Requirements, PS Docket No. 07-114, *Fourth Report and Order*, FCC 15-9,¶¶ 69-71 (Feb. 3, 2015) ("*Fourth Report and Order*").

[34] *Id.*, ¶ 57 n.134 (*quoting* Comments of Public Knowledge, *et al.*, PS Docket No. 07-114, at 3 (Dec. 15, 2014).

These same concerns do not exist with respect to coordinate-based location data produced by consumer handsets using their reception of beacon signals and incorporated pressure sensors. In fact, all smartphones on the market today already produce relatively accurate horizontal location data using GPS and other resources. This information is currently used to support E911 emergency response, albeit to outdoor locations where the information is accurate. The information is also already used for countless commercial purposes, including targeted marketing to consumers, with well-known and documented privacy and security constraints. The public permits these capabilities in their smartphones in part because location services are often highly beneficial to consumers (particularly traffic mapping programs) and also because consumers are able to individually determine which software applications have access to location information, or to turn them off entirely (except when calling E911) to heighten privacy or conserve battery.

The Commission's implementation of its 50 meter x/y and proposed 3 meter z-axis requirements through coordinate-based location technologies will result in no relevant change to this long-standing relationship between consumers and their smartphones. Consumers will still be able to limit the use of this data by their smartphones and turn it off entirely when they desire (except when calling E911). The only real difference is that the location information will now be as accurate in indoor locations as it has long been in outdoor locations. Therefore, no reason exists for the Commission to adopt rules that restrict the use of z-axis data to 911 calls or impose a data privacy and security framework similar to what was adopted by the Commission for the NEAD.[35]

[35] *Fourth FNPRM*, ¶ 29.

V. A VERTICAL LOCATION METRIC OF 3 METERS WOULD PRODUCE SUBSTANTIAL QUANTIFIABLE BENEFITS

The *Fourth FNPRM* requests comment on whether the adoption of a 3 meter z-axis metric would produce the desired level of benefits in a cost effective manner, including the expected number of lives saved by adopting a 3 meter metric as compared to a different metric.[36] The Commission, however, previously engaged in an extensive analysis regarding the anticipated benefits of more accurate indoor location information for wireless callers to E911 and that data is fully applicable to its proposed 3 meter z-axis metric.[37]

Specifically, the Commission conducted an analysis that tested the statistical relationship between ambulance response times in Salt Lake City with the mortality outcomes for the transported patients.[38] The study found, *inter alia*, that "a minute increase in response times increases mortality by between 8[%] (measured 1 day after the initial incident) and 17% (measured 90 days after the initial incident)."[39] The study further concluded that a one minute *decrease* in response time would have an increasingly beneficial result (above 17 percent) with every minute saved.[40] The study explained the likely reason for these ever increasing benefits, theorizing that

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[36] *See id.*, ¶ 30.

[37] *See* Wireless E911 Location Accuracy Requirements, PS Docket No. 07-114, *Third Further Notice of Proposed Rulemaking*, FCC 14-13, ¶¶ 27-37 (Feb. 21, 2014) ("*Third FNPRM*").

[38] *See id.*, ¶ 33 n.70 (*citing* Wilde, Elizabeth Ty, "Do Emergency Medical System Response Times Matter for Health Outcomes?," 22 Health Econ. 7, pp. 790-806 (2013) ("*St. Louis Study*"), available at http://www.ncbi.nlm.nih.gov/pubmed/22700368 (*last visited* May 20, 2014)).

[39] *St. Louis Study* at 791.

[40] *Id.* at 799.

"[t]he sooner the paramedics arrive, the less the damage, and the smaller the later chance of death."[41]

The Commission employed this study to argue that "a one-minute reduction in response times would have resulted in an annual savings of 746 lives," which, when extrapolated across the entire country, "could save approximately 10,120 lives annually."[42] The Commission's analysis made very conservative assumptions and still arrived at an overwhelming economic benefit to the nation.

Of course, for these benefits to be realized, evidence must exist that the provision of vertical location information to first responders with an accuracy of +/-3 meters would reduce response times as compared to the status quo. Compelling evidence of this conclusion already exists in the record of this proceeding. Specifically, field tests conducted by emergency first responders in San Francisco in 2014 revealed dramatic reductions of between 4 and 17 minutes in search times with the addition of vertical information with an accuracy of +/-3 meters.[43]

Given these substantial improvements in response time, the Commission's use of an exceedingly modest one minute improvement in response time in its cost/benefit analysis inevitably underestimated by a substantial amount the quantifiable benefits of providing emergency first responders with z-axis information with an accuracy of 3 meters. Although these findings are several years old, the only variable that has changed in the interim is the ever

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[41] *Id.* at 800.

[42] *Third FNPRM*, ¶ 33.

[43] *See* Letter from San Francisco Public Safety Organizations to Marlene H. Dortch, Secretary, Federal Communications Commission, PS Docket No. 07-114, at 2 (July 14, 2014) (providing test results showing the benefits to public safety of access to vertical location information provided by NextNav's technology, which, at the time, was already demonstrated to have a vertical accuracy of within 3 meters).

increasing use of wireless phones by the public, thus further increasing the benefits that can be expected from the adoption of a 3 meter vertical metric. Therefore, the Commission must conclude that its pre-existing cost/benefit analysis provided a very conservative estimate of the substantial economic and public health benefits that will be achieved through the adoption of the proposed 3 meter z-axis metric and therefore the implementation of the Commission's proposal is fully justified.

VI. THE COSTS OF A 3 METER VERTICAL REQUIREMENT ARE MODEST AND REASONABLE

As the Commission is aware, the primary tools to enable the provision of highly accurate vertical location information to emergency first responders are small, inexpensive barometric pressure sensors and, as the *Fourth FNPRM* observes, nearly all smartphones on the market appear to be equipped with barometric pressure sensors.[44] Adding barometric pressure sensors to those handsets that currently do not include them (generally feature phones and lower-end smartphones), does entail additional costs. Sensor costs, however, have fallen significantly over time and continued price reductions are anticipated by sensor manufacturers,[45] but pushing the handset ecosystem to include this capability in all new handsets is not trivial, and some level of handset cost impact should be expected.

In order to calibrate the pressure sensors within handsets in real time, wireless carriers and location service providers can use publicly available data from the National Weather Service, or

[44] *Fourth FNPRM*, ¶ 26 (citing several reference sources).

[45] *See, e.g.,* Letter from Christopher D. Imlay, counsel to Robert Bosch LLC, to Marlene H. Dortch, Secretary, Federal Communications Commission, PS Docket No. 07-114, at unnumbered page 3 (Jan. 2, 2019) (observing that, "[a]s with all components, increased [barometric pressure sensor] adoption is resulting in price erosion and these sensors are becoming commodities in the DOM (bill of materials) of smartphones").

crowd-sourced weather information, both at nominal cost. NextNav, however, does not believe its demonstrated level of accuracy can be achieved without supplementing this data with a managed network of calibrated reference points. NextNav's weather facilities can be collocated with its MBS beacon transmitters on existing RF antenna sites, minimizing their cost.

The only remaining element that is needed is a software update to existing smartphones in order to instruct the smartphone to receive the over-the-air reception of the calibration signal from weather stations and to use that signal to calibrate the pre-existing barometric pressure sensor. The software necessary to ensure accurate sensor calibration and to offset local environmental variances have been proven effective with a variety of popular barometric pressure sensors and future sensors are expected to be equally able to fulfill this function with no additional premium costs. For many existing smartphones, the addition of this software can be completed during a scheduled over-the-air update of the handset's operating system.

Given these modest expenditures, NextNav can provide 3 meter compliant z-axis services in the Top 50 CMAs to wireless carriers at a nominal cost (in aggregate, less than a penny per month per handset). A key factor in achieving this low cost is the fact that multiple wireless carriers can use the same vertical location services, sharing the common infrastructure expenses. As the 2013 CSRIC Test Bed Report explained, the use of a "shared infrastructure approach, like GPS, helps ensure the cost of the service is competitive."[46] The CSRIC Report also noted the operational and maintenance savings associated with solutions that remain separate from the carriers' call and data-carrying RAN infrastructure, which would not be impacted by ongoing RAN network modifications and enhancements, and which could be cost shared among multiple

[46] *See* CSRIC III WG3, Indoor Test Report to CSRIC III WG3 Bay Area Stage-1 Test Bed at 45 (Jan. 31, 2013).

parties.[47] Given these various factors, the Commission can appropriately conclude that the cost of providing 3 meter vertical location accuracy is exceedingly modest, particularly as compared to the substantial benefits that will be achieved.

Finally, the *Fourth FNPRM* seeks comments on whether the costs of providing vertical location services would be different if the Commission adopted a z-axis metric of 2 or 5 meters. As discussed previously in these comments, although NextNav's location service has demonstrated sub-2 meter accuracy, additional work is needed to ensure that this level of service can be provided on a consistent basis. Therefore, although the additional cost of providing 2 meter accuracy may eventually prove to be modest, this cannot yet be guaranteed.

As for the provision of 5 meter vertical accuracy, NextNav has already designed its network to provide sub-3 meter accuracy. The provision of less accurate service would not reduce or eliminate any of the costs identified above. Therefore, the Commission should conclude that the costs of providing 5 meter versus 3 meter vertical accuracy are generally the same. In contrast, as the public safety community has strenuously highlighted, the differences in the resulting benefits are substantial and persuasive.

VII. ALTHOUGH THE COSTS OF 3 METER VERTICAL COMPLIANCE IS MODEST, THE COMMISSION COULD REFRAME ITS VERTICAL LOCATION REQUIREMENT TO REDUCE COSTS AND BETTER TARGET COVERAGE

As discussed in the previous section of these comments, the costs of providing highly accurate vertical location information fall into two categories: handset costs and infrastructure costs for calibration. Where barometric pressure sensors already exist, the former costs are the

[47] *See Id.* at 53-54 (explaining that "[l]ocation technologies that allow costs to be shared across carriers are preferred" and location technologies should be independent from (1) the wireless network, (2) cell site locations and density, (3) changes in frequencies, bands, and deployment configurations, and (4) Radio Access Network technology changes).

most modest. In order to reduce the infrastructure costs even further, the Commission may want to consider revising its existing requirements regarding the geographic locations where z-axis services must be provided.

The current rules require the provision of z-axis information to 80 percent of the population within each of the top 50 CMAs (or a dispatchable location with 25 percent density). It is unclear, however, whether accurate vertical location information is urgently needed in every portion of the top CMAs, particularly in suburban and rural areas with a large preponderance of one and two story residences. Therefore, one factor that might reduce the costs of vertical location compliance while potentially improving the benefit would be requiring compliance based on coverage of 80 percent of the buildings that exceed three stories in each of the top 50 CMAs, rather than based on the residential locations of 80 percent of the population. This could reduce costs while enhancing benefits because it would permit location service providers to focus deployment of their weather calibration reference points where they are most needed to achieve the mission (and correspondingly, to avoid deployment in areas where they do not add significant value).

Such a change to the rules would also heighten the benefits of the Commission's vertical location requirements by increasing the likelihood that z-axis service will be provided to small clusters of multi-story structures such as office parks, universities, and hospitals, which may be outside of primary population centers, but the tenants of which could benefit significantly from highly accurate vertical location services. Fortunately, existing databases are available that identify the locations of buildings that exceed three stories and such information could be used to certify compliance with such a requirement. For example, building height data is available through open resources such as OpenStreetMap.Org, through private vendors such as MapBox and CoStar, and some cities, such as New York and San Francisco, release building height data for local

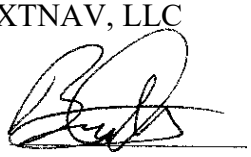
planning purposes. This same approach could also facilitate the eventual extension of the Commission's vertical location requirements to urban, multi-story areas outside the top 50 CMAs.

VIII. CONCLUSION

The lengthy record in this proceeding clearly demonstrates that a 3 meter metric for vertical location accuracy is both technically achievable and would provide enormous benefits to public safety at minimal cost. The public is fully justified in expecting that the wireless industry, public safety, and the Commission will work together to see that technological innovation is employed comprehensively to ensure that callers to E911 emergency services will receive assistance in an expeditious manner. Consistent with this expectation, the Commission should promptly adopt a 3 meter vertical metric and mandate that the major wireless carriers implement this capability within the top 25 CMAs by April 2021 and in the top 50 CMAs by April 2023.

Respectfully submitted,

NEXTNAV, LLC

By: 

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